Online tools are increasing the speed at which scientists make discoveries

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Credit: lizzardo via flickr

Not all research papers receive their own hashtag on Twitter. But #arseniclife (as it was dubbed in tweets) was no ordinary paper.

Last November, the research journal *Science* released an online version of a paper that made some very bold claims: scientists had identified bacteria that could use the toxic heavy metal arsenic instead of phosphorous in the backbone of its DNA. Researchers had previously discounted this possibility, and ruled out arsenic as a potential sign of life on other planets. If this finding were true, it would dramatically change how scientists looked for life elsewhere in the universe.

Within days, however, scientists and science bloggers alike had raised

some serious concerns about whether the scientists actually identified an arsenic-tolerant bacterium. On June 3 -- six months after the initial firestorm -- "Science" officially released the print version of the arsenic bacteria paper, along with official commentary from several different scientists, outlining their misgivings about the study.

This commentary was virtually identical to the objections raised by bloggers in the first week after the paper's publication. The initial informal review brought together a small group of people, who scooped one of the world's pre-eminent science journals by half a year. Although the paper on arsenic and bacteria may be the most notorious example of scientific discoveries and discussions zooming ahead of established routes, there are many others. The proliferation of online tools such as blogs, archives of pre-released research articles and freely accessible experimental data is increasing the speed of science.

Not only do these tools accelerate science, said Rosie Redfield, a microbiologist at the University of British Columbia and one of the first scientist-bloggers to question the arsenic study's findings, they also change where the discussion happens and who can participate. Online tools have enabled scientists to have these conversations faster, and in the public sphere. "Anyone who wants to can see what's being said," Redfield said. "It's not a difference in what we're saying; it's that we're saying it publicly."

New Discussion Tools

Scientists don't have to wait until studies appear in scientific journals to begin discussing the results. A website known as arXiv.org (the "X" is really the Greek letter chi, so it's actually pronounced "archive") allows scientists to upload drafts of research articles and get feedback from their peers even before the research is formally submitted to a research journal. Paul Ginsparg, a physicist at Cornell University, started the

website over 20 years ago as a way to maximize conversations about research. Ginsparg said that arXiv gives scientists advance feedback on their research, allowing them to tweak experiments almost as soon as they are finished.

"Sometimes that means finding out an idea is wrong, but that's also speeding up science," Ginsparg said.

Doing science faster only matters if it also means science is done better, Ginsparg said. Fostering better, quicker science means more conversations between scientists, more timely feedback, and an efficient way to ferret out incorrect results. Although arXiv isn't a foolproof way of ensuring these three things happen, increasing the rate at which critical eyes evaluate research results has undoubtedly helped thousands of scientists produce better results.

If allowing your colleagues to freely and openly comment on drafts of your research articles can speed up science, then Matthew Todd figured that involving them in every step of the research would yield even better results. By putting all of his experiments and data online and making them freely available for anyone to use and comment upon, Todd, an organic chemist at the University of Sydney in Australia, was able to refine the drug currently used to treat the devastating parasite disease known as schistosomiasis with a minimal price increase.

The current drug praziquantel is cheap enough, but the pill is very large and bitter-tasting, both of which interfere with patients taking the drug properly. Praziquantel consists of a 50/50 ratio of an active ingredient that fights the disease and its mirror image, which is both biologically inactive and the source of bitter taste. Todd knew that creating a pill that contained only the active ingredient would solve both his problems. He couldn't take his problem to the pharmaceutical industry, since that would drive up costs too much. Instead, Todd took his research problems

online.

"When you normally have a problem, you walk down the corridor and ask someone for help," Todd said. Since he didn't know anyone who might be able to contribute, "the smart thing to do was open it up and let anyone chip in," Todd said.

On a website devoted to the project, Todd shared all of his research data in an online lab notebook through openwetware.org. Advice poured in from around the world, and Todd's team was able to successfully synthesize a pill containing only the right-handed version of praziquantel.

All three of these scientists say that the key to accelerating science is to keep the access doors open. That means letting any interested person view and use the data. It means encouraging discussions and debates both online and off, in blogs, on Twitter, and within the scientific community. Only that way, they say, will we truly reap the benefits of more rapid scientific innovation.

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